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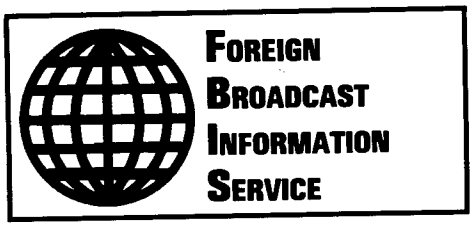

JPRS Report

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TELECOMMUNICATIONS

AEROSPACE

France: Zero-Gravity Parabolic Flight Experiments Noted

93BR0212 Paris SCIENCES ET AVENIR in French Dec 92 p 16

[Text] As if to underscore the economic nature of zero-gravity research made possible by parabolic flights, two zero-gravity Caravelle missions were performed by the CNRS [National Center for Scientific Research] at the end of October—while Columbia was in orbit—on behalf of public and private laboratories in the Provence-Alps-Cote d'Azur region. The takeoffs were from Marseille-Marignane.

On each occasion, a dozen parabolic arcs provided a total of four minutes of zero-gravity. One experiment, on behalf of the Nice University Condensed Matter Physics Laboratory, looked into the auto-organization of magnetic spheres. Sensorimotor and stimulo-vibratory adaptations were studied on behalf of the Saint Jerome de Marseille faculty. The CNRS's Functional Neurosciences Laboratory in Marseille-Laminy chose zero-gravity research into axial synergy as their theme. The Regional Center for Popular Sports and Education, in Aix-en-Provence, performed prophylactic muscular exercise tests for space missions. Mercuric iodide monocrystal growth was studied by the CNRS' Research Center on Crystal Growth Processes. The Training and Research Unit for Sports and Physical Activities chose the game of darts in order to better understand motion coordination in zero-gravity.

Finally, the Cannes Space Camp filmed shots from which an educational movie on the laws of physics will be made.

Competitive Advantages of Airbus, Boeing Aircraft Compared

93BR0213 Paris SCIENCES & AVENIR in French Dec 92 pp 76-80

[Article by Jacques Morisset: "The War of the Giants"]

[Text] Airbus Industrie and Boeing are engaged in fierce competition to make a mark on the world market with their enormous twinjets, which are capable of traveling nearly 10,000 kilometers nonstop. The demand for them is colossal; 4,700 aircraft will be delivered between now and 2010, in other words, 22 aircraft a month!

The start of flight tests in Toulouse on Airbus's latest aircraft, the A-330 twinjet, constitutes a peak in the merciless struggle between the European consortium Airbus Industrie and America's Boeing. The backdrop to this battle is the underlying wish of both manufacturers to exclude the other from the world market. This is shown by the already spectacular episodes of the legal wrestling match carried out within the scope of GATT [General Agreement on Tariffs and Trade], with each accusing the other of unfair practices based more or less on hidden government subsidies. Begun by Boeing, this battle was recently brought to an end—or rather the hatchet was temporarily buried—by an official agreement between Washington and Brussels.

The agreement determines the level of subsidies to which manufacturers will be entitled, and the funding procedures for each order. It virtuously declares that politics should not intrude on the choice made by the purchasers, from the "independent" airlines of the United States to those of the third world, whose financial health sometimes depends greatly on their governments which all want to have their "own" airline. There should be some interesting times ahead, as it is really not possible to see how to avoid the more or less friendly pressure that has—and will be—exercised on these governments to encourage their airlines to make the "right choice."

What factors does this choice depend on? Pressures aside, the technical reasons (performance, suitability for the future user's network, availability for delivery) are only quite rarely given priority. Without going so far as to say that all aircraft are equal, it must be acknowledged that for some years now their features have been very similar. The deep-rooted habits of the airlines, i.e., their fairly close links with their government contacts, and their wish not to upset these relationships count for a great deal. Finally and most significantly, in an economic climate which has become very difficult, the conditions for financing their purchases (interest rate and term of a loan) are becoming very important: To the point where negotiations are first and foremost of a financial nature.

Thus, the two aircraft will truly be the standard bearers of the two manufacturers. In the "lower" category, that of the "small" 150-seater aircraft, the A-320 has already made a rapid breakthrough compared to the two aircraft which until now monopolized this sector. The B-737 and Super-80 (Douglas) must now share the market with the A-320. This is the most important market in terms of the number of aircraft ordered, if not in terms of turnover.

It is in the light of this situation that the chances of the Airbus 330 must be examined against its rival, Boeing's future B-777. The figures show a remarkable convergence: same fuselage length, although the American aircraft has a slightly wider fuselage and thus slightly greater capacity (in terms of the number of seats). This latter aircraft will also be appreciably heavier when empty, at takeoff and on landing, but will carry more fuel; it will therefore be able to travel slightly longer distances.

In fact, these new wide-body aircraft are first and foremost long-haul aircraft in the 8,000/9,000 km class (with full passenger load). As they can also be economically used over short distances, the A-330 and the B-777 could replace almost all the wide-body aircraft in service. Many airlines in fact consider that their B-747s are rather too big and too heavy, and therefore obliged to

needlessly consume fuel to carry tons of excess fuselage. Boeing and Airbus analyze this point in the same way: The optimal aircraft for the coming years will be smaller than the B-747 and larger than the A-300. And able to provide peak operation over short as well as long distances.

It is here that the strategies of the two manufacturers diverge: Although the twinjet model is judged to be the best in all cases where it is possible (two engines, even if very large, will ultimately be less expensive to purchase and maintain than four medium-sized engines), it still carries a penalty. The explanation is that the need to provide for the event of an engine breakdown just after takeoff results in excessive engine power, which is more of a nuisance with twinjets since they lose 50 percent of available thrust, compared with 25 percent for four-engined jets.

Excess engine thrust means an increase in the empty weight and an increase in the aerodynamic drag of the nonfunctioning engine. Hence there is a decrease in the quantity of fuel that the aircraft can carry and slightly higher fuel consumption. Conclusion: given equal technology, the twinjet model is still the best for short and medium distances; the four-engined model is optimal for long journeys.

So as not to have to develop, certify, and mass produce just one aircraft, Boeing has opted for a single aircraft available in several versions: "A" for medium and long-haul, "B" for long and very long distances, and "C" possibly in a future stretched version with even greater capacity (thus very close to that of the B-747). Advantage: less costly investment. Disadvantage: As the wing is the most expensive component to produce, a single outsized wing must be adopted to contain the needed fuel and to enable takeoff when fully loaded. This can be seen in the weight of the B-777 "A," which is 15 tonnes heavier empty than the A-330-300 (the basic aircraft), with a few more seats and a few more kilometers. And since the cost of an aircraft and its operation are directly proportional to its weight....

Airbus Industrie has chosen the opposite strategy, that of the twinjet and four-engined jet (A-340), but has taken great care to minimize extra cost through a policy of extensive synergy; not only are the fuselage, the stabilizers, and the various systems (the hydraulic and electric generation systems, flight controls, and pressurization) identical in both aircraft but also the landing gear (the four-engined model, which is 20 percent heavier, simply gets an extra axial gear). Even for the wing, the engineers have succeeded in designing an identical basic structure (apart from the thickness of the metal) capable of carrying four engines developing 15 tonnes of thrust just as well as two engines developing 30 tonnes. This is a truly amazing feat which required intensive use of CAD [computer-aided design] to reconcile the irreconcilable (the aeroelasticity problem).

The number of prototypes must therefore be doubled, and there must be a considerable increase in the number of flying hours necessary to perfect the two aircraft, which are in a sense semi-identical twins. The cost of certification will also be double. In exchange, Airbus Industrie is offering aircraft to airlines which are ideal for the two sectors of use, without the least upset to the fleet managers or to the personnel, who are easily able to operate the A-330 as well as the A-340 (even on the flight deck).

The A330-300 (and its derivatives) should thus be better than the B-777 "A" and the A-340 better than the B-777 "B." Initial figures confirm this assessment, particularly since Boeing, in order to simplify ground operations (ground traffic, positioning in existing hangars) has opted for an optional solution which is interesting but clumsy and expensive. The wingtips of the B-777 will be able to fold back to bring the wingspan down from 61 to 47 meters. Airbus Industrie turned down this solution, which was judged too burdensome (in terms of weight—around 1.5 tonnes—and in terms of extra production cost, without considering the risks). It will be for the airlines and the airport authorities to extend their hangars if necessary....

Another factor affecting the choices made is the development and delivery time schedule. The A-330 began its flight tests at the beginning of November. Deliveries will commence in a year's time (the first A-340s will be available for delivery beginning next January). The first B-777, whose final assembly will only begin in Everett (near Seattle) in about February, will make its maiden flight in mid-1994 and the earliest deliveries are scheduled for May 1995. This is a difference of 18 months compared to the A-330, and 46 months if the B-777 "B" is compared to the A-340.

Despite Boeing's still slightly dominant position—for how long?—these considerable differences could alone explain the fast start made by the A-330/340 duo. There are firm orders for nearly 300 aircraft from some 30 airlines (more than 500 aircraft placed if options are taken into account), as against 200 B-777s to be delivered to around 10 airlines.

In fact, Boeing's "delay" can primarily be explained by a late launch (October 1990) with only one customer (United Airlines) instead of the four or five customers generally required to start up a new program. On the very competitive North American market, Boeing has been outstripped by Airbus Industrie which has already sold the A-330 alone to Continental Airlines, Northwest, and TWA (five firm sales plus 30 options), without counting the A-340s (Continental, Northwest); in addition, the airlines which are hiding behind the leasing companies, such as GPA and ILFC, have already placed firm orders for the A-330 and A-340. On the most promising market, that of the Far East, Air Lanka, Cathay Pacific, Garuda, Korean Air, MAS, Thai Airways, and probably Singapore Airlines have already decided to acquire around 70 A-330/340s. Boeing is only

doing slightly better, despite the formidable advantage it is receiving through its cooperation with the Japanese aeronautical industry on the B-777 (45 aircraft already placed with Japan Airlines and All Nippon Airways). In Europe, only British Airways, Euralair, and Lauda Air have chosen the B-777 (36 aircraft placed), whereas Air France, Air Inter, Air Portugal, Austrian Airlines, Euralair, Iberia, Lufthansa, LTV, THY, and UTA [Air Transport Union] have placed orders for more than 100 A-330s and A-340s, 76 of which are firm orders.

For the moment, the balance is much in favor of the European aircraft. For the first time in its history, Boeing is no longer the leader in a market sector of the future. Despite the complexity of its decisionmaking process, Airbus Industrie has pulled ahead in terms of schedule and technical choices. For the European consortium, which has the wind in its sails, this is tremendously encouraging; particularly as it is a market which Boeing itself has estimated to be worth nearly 4,700 aircraft by 2010. In other words, there are an average of around 250 aircraft to be delivered each year or 22 aircraft a month! This is ample justification for the extensive facilities already specially built for this purpose in Toulouse by Aerospatiale and the new 15-hectare factory which is under construction in Everett for the future B-777 production line. Moreover, Boeing has already announced a Super-B-777, stretched by 10 meters, capable of carrying 550 passengers over 7,000 km, and a heavy version (294 tonnes at takeoff) capable of traveling nearly 15,000 km.

Observers are curious to know Airbus Industrie's response to this race for giant twinjets; however, one of those in charge of research into the A-330 did not hide the fact that it is "an open-ended aircraft" and that it would "give rise to numerous versions, each one larger and heavier than the last." "The A-330 is our future." There is thus everything to hope for!

Two Prolific Families

	A330-300	A330-300X	A330-400X	B777-A	B777-B
First deliveries	end 1993	1994-95	1996-97	May 1995	Dec 1996
Three-class capacity	295 seats	295 seats	335 seats	328 seats	328 seats
Two-class capacity	335 seats	335 seats	379 seats	400 seats	400 seats
"High-density" capacity	440 seats	440 seats	495 seats	440 seats	440 seats
Range (km)	8,600	10,150	7,300	9,000	12,200
Engine thrust (tonnes)	2 x 29	2 x 34	2 x 34	2 x 33	2 x 38
Fuselage diameter (m)	5.64	5.64	5.64	6.20	6.20
Overall length (m)	63.70	63.70	70.00	63.73	63.73
Wingspan (m)	60.30	60.30	60.30	60.93	60.93
Wing surface (m^2)	363	363	363	414	414
Takeoff weight (tonnes)	212	230	230	242.7	267.6
Landing weight (tonnes)	174	185	200	202	206.4
Empty weight (tonnes)	119.5	123.2	130	135	138.2
Payload (tonnes)	44.5	49.8	59		
Tank capacity (liters)	93,500	98,250	95,500	117,335	169,190
Number of LD3 containers	32-33	32-33	40-41	32	32

[Caption] NB: Boeing is also considering the development of a stretched version equivalent to the A330-400X. Available in around 1998, it will use new engines developing 40 tonnes of thrust.

AUTOMOTIVE INDUSTRY

France: PSA Introduces 'Cold Box' Crankshaft Manufacturing

93WS0143C Paris INDUSTRIES ET TECHNIQUES in French 6 Nov 92 pp 60, 61

[Article by Michel Le Toullec: "PSA Chooses 'Cold Box' Casting To Manufacture Crankshafts its Diesel Automobiles"]

[Text] Installed at the Charleville-Mezieres site at a cost of 104 million French francs [Fr], this line will produce 6,000 pieces a day at full capacity.

For its new crankshaft production workshop at Charleville-Mezieres, PSA [Peugeot Corporation] chose the innovative so-called top-pouring "cold box" technique. Peugeot's objective was to obtain dimensionally more precise and, at the same time, more homogeneous spheroidal graphite [SG] cast iron pieces. The workshop, representing an investment of Fr104 million, is designed to produce 6,000 crankshafts at full capacity, with three shifts totaling 64 persons. It has been operational since September and is currently producing 1,500 pieces a day with one shift.

This investment is in line with PSA's policy of generalizing the use of SG cast iron crankshafts, as an alternative to forged steel crankshafts, in all of its passenger

cars. The Charleville site thus combines in this unit, in a single building, the melting, casting, and finishing operations. PSA justifies its choice of the "cold box" technique—its first use of this technique—by comparing it with the other methods of molding in hard sand, such as the croning [shell-molding] process and the croning metallic-shell molding process. The new method produces, first of all, a crankshaft without a casting sprue, that is, without the excess of metal that generally adheres to the piece. "Cold box" casting moreover, unlike the other methods, enables recovery of up to 80 percent of the sand used. The sand regeneration rate is 20 percent.

The method also avoids shortcomings of the other techniques, such as a sizable heating factor and the risk of pollution. And it guarantees PSA a better quality product: a high degree of surface hardness, a good appearance, and very few shrink-hole problems (surface defects owing to shrinkage of the metal during cooling). The rejection rate meets PSA's goal of less than 3 percent at maximum.

The process is being used today for the manufacture of PSA's diesel vehicle crankshafts, but its use would be advantageous for the manufacture of other massive parts as well, such as camshafts in particular.

[Box p 60]:

The Top-Pouring 'Cold Box' Method

This method of molding is one of the so-called hard-sand techniques. After the molten metal has been poured, the portion of the sand in contact with the piece—approximately 20 percent of the total—becomes a coolant. This part of the sand loses its hardness and can be removed without mechanical tools. It can then be regenerated and reused to fill the mold. The remaining 80 percent is not subjected to any thermal shock, and can be reused as is, as filler and support for a new pouring.

France To Test Natural-Gas-Fueled Bus

93WS0163D Paris AFP SCIENCES in French 26 Nov 92 p 47

[Article entitled: "The First Natural-Gas Bus Prototype Readied in Marseille"]

[Text] Marseille—Marseille will be home to the first prototype for a bus fueled by natural gas. The Marseille Public Transport Co. (RTM) mass transit system plans to experiment with the bus for a year, says the RTM, starting in March 1993.

The RTM's goal is to contribute to urban ecology by reducing polluting emissions and roughly 30 percent of irritating noises, and to use a substitute fuel that is "widely distributed throughout the world," says Pascal Maguet, an engineer with the RTM's vehicle technical department. The prototype contains six tanks of 150 liters each, placed in the roof "for safety reasons." The bus can travel 200 to 300 km before filling up again.

The tanks were subjected to numerous tests to insure the vehicle's optimal safety. They withstood violent impacts, pressure of 600 bars, a thrown grenade, and fire from an automatic weapon and penetrating bullet gun.

Renault Vehicules Industriels (RVI), which has designed an engine adapted for natural gas, Gaz de France, RTM, the Regional Industry, Research and Environmental Directorate (DRIRE), and the ministries of Transport and Industry all teamed up on the project. Adapting the vehicle to run on natural gas should raise its purchase price by about 10 percent, according to Mr. Maguet. Natural-gas buses are already operating in Holland, Germany, Belgium, Australia, Canada, and the United States.

COMPUTERS

Thomson Presents Mass-Storage Digital Tape Recorder

93BR0230 Paris ELECTRONIQUE INTERNATIONAL HEBDO in French 26 Nov 92 p 16

[Article by Florence Ladouce: "Thomson Prepares the Recorder of the Future"]

[Excerpts] As a world's first, Thomson's LCR [Central Research Laboratory] presented a demonstration model of a digital recorder whose "massively parallel" design makes it possible to contemplate the storage of one terabit [Tbit] of data on a standard Hi-8 cassette with a transfer rate of 100 Mbit/s. Two keys: a matrix-structure write head and a magneto-optic read head, both of which are static.

How will tomorrow's digital recording systems in our HDTV [High-Definition Television] sets look like, or the systems which will store multiple gigabytes of computer data? To record HDTV, for example, one of many questions is which system will be capable of operating at a transfer rate of 100 Mbit/s for two to three hours with a storage system which can hold 1 terabit (10^{12} bits), and which will have to be small and inexpensive if it is to find its way in the consumer electronics market? The optical disk is the medium which today presents the highest density (1 bit/micron^2). However, to store 1 Tbit, it would require a surface area of 1 m^2! The conventional storage system on magnetic tape remains a serious contender in answer to this challenge.

One Terabit on a Hi-8 Cassette

At the Physics fair which was held last week, Thomson's LCR presented, as a world's first, a demonstrator model of a digital magnetic tape recorder. Its totally innovative design makes it possible to envisage the development of systems that can store 1 Tbit of uncompressed data on a Hi-8 cassette with a data rate of 100 Mbit/s. The key technologies used in this system which has a recording density of 1 bit/micron^2 are: multitrack, static heads,

matrix-structure write head, magneto-optic read head (Kerr effect), and CCD [charge-coupled device]. [passage omitted]

The demonstrator model presented today by the LCR (tape speed of 2.6 cm/s, track width of 18 microns, data rate of 20 Mbit/s) is based on innovative, "massively parallel" recording and reading concepts. The fixed write head can write to 384 tracks in parallel. It owes this prowess to its matrix structure (12 x 32 inductive heads configured in rows and columns) and multiplexed addressing (the same as in flat screens), which makes it possible to simplify connections. However, it differs with flat screen technology in that its "row" command conductors are shaped obliquely (i.e.,non parallel to the tape), so that two gaps placed side by side on a single row correspond with two adjacent tracks on the tape. This planar head was developed using a ferrite substrate that has been etched with grooves to support the rows and columns of conductors (the core of the head) and a layer of Sendust (FeAlSi) forming the "poles and gaps." The particular process used for the production of the thin film is based on successive deposition and etching steps and allows the development of very narrow gaps, in this case made of aluminum.

The read head testifies of as much—if not more—originality. It is an "active head" based on the magneto-optic principle of the Kerr effect, like the disks bearing the same name: It transforms a magnetic image into light with varying polarizations which can subsequently be detected [by the CCD]. Conventional magnetic tapes are not adapted to a magneto-optic read head. It is at this point that the Kerr transducer comes into play: a prism on which different layers were deposited in a way to form the equivalent of a magnetic head with its poles (the Sendust layers) and gaps (the aluminum layer).

Rotation of Light Polarization

When coming into contact with the tape, the transducer reproduces, within its poles, the magnetic image of a transversal row on the tape, like any head. However, at this stage, a laser beam, which is focused by means of a cylindrical lens to produce a light beam with the same width as the tape, reads in parallel the poles of the Kerr transducer. Depending on the magnetization direction, there is a rotation in one direction or the other of the polarized light, which is then sent to the CCD after having passed through a polarizer. Result: The CCD receives the image of a magnetic row in the form of points with different illumination intensities. The potential of this head is far-reaching: While the transversal resolution of the tape is determined by optical laws (Thomson researchers currently consider a potential track width of 1 micron), its longitudinal resolution is determined by the thickness of the dielectric layers (i.e., the gap width) of the Kerr transducer (250 nanometer in the case of the demonstrator). Over and above this, taking into account the innovative properties of the materials used, the transducer does not require separation etching for the elementary heads. This means that it is capable of reading any recording format....

Thus, we can already imagine the potential impact of this digital recording concept (heads capable of writing to 1,000 tracks are in the process of being developed by LCR and transfer rates of 1 Gbit/s are envisaged) both on the consumer electronics market and in professional civilian and military domains. But, we know that a concept, no matter how "attractive," is not sufficient to introduce a new standard. The future will tell us if Thomson is ready to take up the gauntlet. For the moment, no industrial project has been announced.

DEFENSE R&D

Future Multi-Purpose Tactical Missiles Described

93ES0251A Paris AIR & COSMOS/AVIATION MAGAZINE INTERNATIONAL in French 30 Nov-6 Dec 92 pp 16-22—FOR OFFICIAL USE ONLY

[Article by Pierre Langereux: "Missiles of the Future"]

[Text] French industry is preparing, and in some cases even already developing, a highly diversified and sometimes original panoply of new techniques. These techniques will constitute the "strengths" of future tactical "missilery" in a number of applications by the year 2000.

They will be subsonic, supersonic, and even hyperspeed; propelled by a solid-propellant motor or a solid or liquid ram rocket, preferably a "crude" one. They will be fired vertically, piloted in force, remote-controlled by laser or radar beams, or will navigate via terrain and target reconnaissance or direct vision relayed by optical fibers. Most of them will be "stealth" missiles. And their munitions will be aggression-proof, in other words "RRMed" (reduced risk munitions).

Of course, not all the missiles will make indiscriminate use of every one of these features. To the contrary, each one will employ only one or more of these advanced technologies, depending on its mission and manufacturing and operational constraints (performance, cost, and so forth).

The surface-to-surface MICA missile, for instance, must be multitarget, rapid, agile, and, above all, impervious to countermeasures. But the air-to-surface subsonic Apache will have to be very stealthy and able to navigate by following the terrain through altimeter resetting and landmark recognition.

The new surface-to-air missiles will be hyperspeed projectiles like the VT1. Likewise, future antimissile missiles will have to be fast but, most important, maneuverable at interception through a combination of aerodynamic control and piloting in force, in the tradition of Aster. The short-range antitank missile Eryx must

be launchable in a confined space, while the longer-range Trigat will be guided by a laser beam or infrared-imaging homing head. And various missions—antivehicle or antiship—will be feasible using the astonishing fiber-optics missile Polypheme.

Antiship missiles must be able to dodge decoys and jamming through improved terminal guidance, as the Exocet MM40 Mk2 does with its new ADAC Mk2 homing head. Dassault Electronique believes that the ADAC Mk2 "considerably improves the operational effectiveness of the Exocet in the face of all the electromagnetic countermeasures conceivable beyond the year 2005." Moreover, according to Jean-Louis Fache, the director of Aerospatiale-Missiles, there are plans to enhance all the Exocets, including the AM39 and SM39, with Mk2's after the MM40.

But future antiship missiles will also be required to fly farther and faster, at supersonic speeds. One way they will do this is through ram propulsion—liquid on the ANS and "crude" on the ANL. The new "crude" powder ram system, still the only one of its kind in the world, will be flight-tested in 1994. It may equip other Aerospatiale or Matra missiles, such as the light antiship missile ANL or the future antiradar missile ARF.

The vast array of knowledge and skills in missilery is the outcome both of long practical experience and new missile design and manufacturing techniques (aerodynamics, guidance, propulsion, detonation science, etc.). It will enable engineers to begin upgrading, or to consider upgrading, practically all of France's "missilery." But the same technological strides also make it possible to construct a few wholly new and even revolutionary missiles. Piloting in force (Eryx, Trigat and Aster) or fiber-optics guidance (Polypheme) are among these new techniques, as Robert Dubernet, director of Aerospatiale-Missiles' Research, explains.

The "PIF" of Aster and Eryx

"Eryx is a unique design," says Robert Dubernet. It is, in fact, the first missile in the world to be equipped with double warheads, firable in an enclosed space and able to be hoisted without support. Ordered by France, the missile has also sparked the interest of Canada and Norway. Eryx will be mass produced in 1994.

The portable Eryx weighs 17 kg with its firing station, and can be launched from a confined space because of its low initial velocity (18 meters/sec). The minimissile is ejected from a cartridge and then accelerated (up to 260 m/s), reaching its maximal range of 600 meters in 4 seconds. Its probability of hitting fixed or moving targets is very high (90 percent), even if the targets are rapid and concealed, thanks to its great manueverability (piloting in force). And its tandem warheads make it highly effective against heavy tanks, even those protected by composite or reactive armor. The two warheads include a big hollow charge (136 mm) that pierces very thick steel (0.9 m) or concrete (2.3 m).

But Eryx's innovative feature is actually its powder booster placed in the front (and not the rear) with its two lateral nozzles which discharge at the center of gravity, with thrust reversers to insure "piloting in force" (PIF).

The same dynamic control concept is used for the third-generation medium-range (2,000 meters) antitank missile AC3G-MP, which is guided by laser-beam sight alignment. In contrast, the long-range (5,000 meters) AC3G-LP employs Sofradir's infrared-imaging homing head (IRCCD) with focal-plane detector. This Trigat will be the first antitank missile in the world equipped with an image-matching, passive infrared homing head, enabling the missile to lock onto the target before firing and insuring great accuracy and immunity from jamming. It will be the main weapon of the Tigre helicopter, which will also be equipped with an Osiris sight for night firing that will be made by Aerospatiale, Sfim, Thorn-EMI, TST, SAT, and ELTRO. The AC3Gs of EMDG (Aerospatiale, British Aerospace, and DASA) will begin service in 1997-98.

PIF was actually invented by Aerospatiale 11 years ago, says Robert Dubernet, for the Aster missile. Different versions of the Aster will be common to all future surface-to-air weapons systems of Eurosam's FSAF program, which is being conducted jointly with Alenia and Thomson-CSF (see AIR & COSMOS/AVIATION MAGAZINE INTERNATIONAL, No. 1398).

Indeed, Aster required engineers to reduce the time constant to make the missile more agile during final interception stage and enable it to instantly realign its path to that of the target while dodging self-defense decoys. This required something more than classic aerodynamic control surfaces or thrust reversers so that Aster could intercept planes or ANS- or ARF-type tactical missiles at 15 to 30 km.

Hence the idea of using piloting in force, by ejecting gas at the missile's center of gravity, combined with strong aerodynamic control (SAC). This piloting in force through four nozzles at the (roll-stabilized) missile's center of gravity is limited by the capacity of the gas generator and kicks in for only 0.6 seconds at the end of interception. It enables the missile guided by the AD4A to be pointed at the target. The AD4A is a Doppler-pulse radar homing head developed by Dassault Electronique. It will be mass manufactured for Aster in 1996 (see AIR & COSMOS/AVIATION MAGAZINE INTERNATIONAL, No. 1398).

Aster's reaction time is thus far superior to Patriot's (0.01 s instead of 0.3 or 0.4 s) due to its "piloting in force" control technique and its lesser inertia. At about 100 kg, Aster is 10 times lighter. With a few adaptations, notably in its guidance (to reduce proximity) and warheads (big fragmentation), Aster will be able to intercept Scud-type ballistic missiles, even maneuverable ones, falling at 2,000 or 3,000 meters/sec.

Hyperspeed and Fiber Optics

Aerospatiale is also considering applying piloting in force to future hyperspeed missiles, notes Robert Dubernet. Indeed, his team is studying a very rapid tactical missile for antitank and/or short-range surface-to-air missions for the year 2010.

The project involves a "multirole" missile that can be used interchangeably against tanks, planes, or helicopters like the Oerlikon missile. But it will be much swifter than the ADATS.

Robert Dubernet believes in hyperspeed, which both slashes missiles' flight time so they can hit very fleeting targets, particularly combat helicopters, and makes it possible to destroy heavily armored targets through the kinetic effect of an impact at over 5,000 km/h.

For the near term, Euromissile's short-range surface-to-air missile Roland and Thomson-CSF's Crotale will be replaced by a new hyperspeed missile, the VT1. The VT1 was developed by the American firm LTV (taken over by Loral) under contract to Thomson-CSF. The first thousand missiles of them were made in the United States, and the next thousand will be produced by Euromissile, under the terms of an agreement soon to be concluded by Thomson-CSF (see AIR & COSMOS/ AVIATION MAGAZINE INTERNATIONAL, No. 1399). The hyperspeed (Mach 3.5) VT1 is highly maneuverable (35 G) and will be able to intercept planes and especially tactical missiles up to 11 km. Integrated into the Crotale NG, it will equip the French Navy's six new Lafayette destroyers in 1995.

Aerospatiale is also banking on the "Polypheme" concept. That is, on a solid-propellant missile that uses visual remote-control guidance relayed by a direct, multiplexed optical fiber link that is unjammable. The principle on which the missile is based has already been tested in flight up to 100 km. According to Robert Dubernet, Polypheme's development, which has been underway for four years with DASA, will conclude with the flight of a complete preliminary missile in 1995.

Aerospatiale plans to use Polypheme for various "surgical strike" missions such as the ground attack of military targets in urban areas, of fixed or moving surface-to-air artillery, of surface-to-surface guns or missiles (Scud), or of command centers (C3I). It is thus proposing a 60-km-range surface-to-surface version to FAR. The last Naval Show highlighted ocean-to-surface versions to attack land or naval targets, coastal artillery to defend a maritime front, and the helicopter-borne variant to protect straits and other strategic maritime areas. But the general staffs differ on the use of fiber-optic missiles: France envisions all kinds of applications up to 30 km, save antitank ones, while Germany is more interested in an antitank missile with a range of under 100 km.

Aerospatiale is also proposing Polypheme as a short-range reconnaissance drone (25 to 30 km). Earlier this summer it unveiled its plans for drones derived from the C22 subsonic target drone (see AIR & COSMOS/ AVIATION MAGAZINE INTERNATIONAL, No. 1384).

Photo Caption Information on the Polypheme

Polypheme uses fiber-optics guidance to visually identify the target, which is pinpointed "live" by the firer who receives an image of the terrain being overflown by the missile on a screen. The picture is taken by the infrared camera in the missile's nose and sent in real time to the firing station through the optical fiber. In return, the optical fiber transmits the firer's target-designation orders to the missile, which then automatically flys to it. At the firing station, the raw image received from the missile is "instructed" (by computer) to display the scene and classify the targets by strike probability (50 to 100 percent). Polypheme's guidance system has already been tested at a range of over 100 km.

The C22 is a remote-controlled (or programmed) target that is propelled by a Microturbo TRI 60 turbojet engine. The missile will serve as a target for Aster. It weighs 640 kg after its boosters are jettisoned, carries a load of 130 kg, and can fly at Mach 0.94 between 10 and 13,000 meters.

But the C22's French maker believes its autonomy and carrying capacity could enable it to be converted into an electronic warfare drone (with jammers) or a reconnaissance drone with a range of up to 700 km. (In the latter case, it could use as sensors the CL 289's optical, infrared cameras, which will be put into service in the French Army in late 1992). In fact, adds Robert Dubernet, "with a few modifications, such as stretching to enable it to carry more fuel, the C22 could even fly as far as 1,000 km!"

An Air-to-Air Long-Range Missile

Aerospatiale is also working on two other designs, a bit more futuristic, for long-range, cruise-type airborne missiles. They are an ASLP air-to-surface and an AALP air-to-air missile.

The ASLP is a project for a supersonic stealth cruise missile adapted for ground attack and may be used as a successor to the Apache and ASMP. Like the ASMP, it is an air-to-surface tactical nuclear missile, propelled by a liquid (heavy fuel) ram that is being proposed by the British TASM program.

However, the ASLP could also spawn a multirole variant to replace the ANS. The Franco-German missile has, in fact, little chance of being developed, despite the obvious value of a (ram) antiship missile that would have been the fastest in the world by 2000 with a speed of Mach 2.3 and a range of 250 km (see AIR & COSMOS/AVIATION MAGAZINE INTERNATIONAL, No. 1383).

Robert Dubernet also reveals that Aerospatiale is trying to get into the air-to-air missiles market which until now has Matra's preserve. The product the company has been

working on is the AALP, a long-range air-to-air missile specially designed to shoot down AWACS-type radar planes.

Curiously, only the Russian arsenal has so far included a missile adapted for that crucial mission. Aerospatiale thinks the job will require a very rapid missile fired at very long range (+ 300 km) and out of sight of the radar plane in order to hit it at high altitude (8,000 meters).

The AALP it is proposing for shooting down such a target—impassive but hyperprotected—would be a ram missile guided by a bimodal, infrared, electromagnetic homing head and equipped with a classic demolition charge, in this case one derived from the ASMP.

For the project, stresses Robert Dubernet, "Aerospatiale offered to collaborate with Matra," which was proposing a derivative of the air-to-air Super 530. Actually, says Philippe Turpin, Matra Defense's strategy director, "There was a convergence with Aerospatiale on this mission, and we presented a joint design to the air force" based on the AALP.

But Matra is primarily concerned with winding up development of its new air-to-air multitarget missile, MICA, in time to equip the Mirage 2000-5s in 1994. Notably the export version of the plane, like the one Taiwan wants to buy. Taiwan's purchase of the plane would make it the first foreign customer for MICA whose main competitor is the American air-to-air missile AMRAAM.

"MICA is a 'top-of-the-line' missile which, like the Apache, offers considerable operational advances," says Philippe Turpin. According to him, MICA's main assets are its versatility and its autonomous, multitarget nature. It can both defend itself at close quarters and perform aerial combat and interception. And MICA is integrated into a multimode system since the missile can be equipped with either an electromagnetic (Dassault Electronique) or infrared (Matra/SAT) homing head.

In this respect, MICA foreshadows future air-to-air, multimode (radar and optical) guidance missiles that will not be made any time soon in France or Europe. Moreover, the United States has scrapped the only project for one (AAAM).

Matra's future air-to-air missile is more likely to sport a dual mode (passive and active) electromagnetic homing head, says Philippe Turpin. And Mr. Turpin explains that priority in developing the MICA will be given to velocity rather than range, to boost average speed without sacrificing manueverability by using a "crude" ram around 2010.

Antiradar and Standoff Missiles

Matra is also thinking about using this ram on a future antiradar missile. The value of such missiles was given a fresh shot in the arm by the Gulf War where American and English HARM and ALARM antiradar missiles were massively employed.

For the time being, Matra is proposing that Armat "evolve technically" into the Mars missile. Mars is derived directly from the big 550-kg solid propellant Armat which has a range of 100 km. But Mars is replacing Armat's five heads with a new broad-band (1 to 18 GHz) homing head that Dassault Electronique developed for ARF. That means Mars might be available in 1995-96.

The ARF (Future Antiradar) is a preproject for a more modern and much lighter missile than the Armat or Mars to equip future Rafale-type fighter planes. But, points out Philippe Turpin, "We do not have the final version of the design, notably relative to the missile's weight, because there are plans to develop it jointly with Germany." This does not raise any industrial problems but does require joint specifications. It brings French and German designs closer together to accomplish the two missions of antiradar and self-protection and penetration using a single missile that will weigh about 200 kg. The missile will have a range of over 100 km and, like Mars, will be equipped with a broad-band, but more rapid, homing head thanks to its "crude" ram.

Matra and its German partner BGT are also studying a smaller, future antiradar missile, with a bimodal—electromagnetic and infrared—homing head. Dassault Electronique and SAT are already working on it with BGT and TST (DASA) in a joint Franco-German endeavor.

According to Philippe Turpin, the new bimodally-guided antiradar missile will probably not be made before 2005, assuming a traditional development period of seven years. Current economic conditions are postponing the start of a new missile program until 1995-96.

In a related area, Matra Defense CEO Noel Forgeard has disclosed that his team has been working quietly on a study of the electronic warfare drone Dragon for the last 18 months under a state contract worth 50 million French francs [Fr]. It is the first French electronic warfare drone project. According to Noel Forgeard, Dragon could become a Franco-German program like the reconnaissance drone Brevel, for which Eurodrone just received a Fr1.4-billion contract shared by Matra Defense and its German partner STN. Brevel is equipped with an infrared heat camera (8-12 microns) and can travel 150 km in stealth flight (see AIR & COSMOS/AVIATION MAGAZINE INTERNATIONAL, No. 1401).

Matra is currently developing the Otomat Mk3 with its Italian partner OTO Melara. The missile is a new version of the long-range (180 km) turbo-propelled antiship weapon. The Otomat Mk3 features new tactical capabilities (trajectory choice, obstacle avoidance, and target selection through spectral signature analysis) and an

improved Thomson-CSF homing head. In fact, it borrows certain devices such as its computer, inertial unit, etc., and the Turbomeca turbojet engine of the torpedo-carrying Milas missile which the same team is developing for 1997. According to Philippe Turpin, the Otomat Mk3 may be ready within two years, by late 1994.

Matra is also studying "a stealth Otomat," alias Teseo, with OTO Melara. This time the Italian government is funding the program (Fr80 million) for a two-year period. The Teseo is a very different missile from the Otomat, although it is still subsonic and, like previous Otomats, is propelled by a turbojet engine up to 180 km.

The preproject for Teseo 2 was already presented to the National Navy in 1991, where it was greeted with some interest. Philippe Turpin says that if the program were to start next year, the missile could be ready for 1998-2000.

Indeed, Teseo 2 would enable Italy to step in for France and the United States as the supplier of future, antiship stealth missiles to replace the Otomats, Exocets, and Harpoons. And Italy could take advantage of the lack of supersonic ANS antiship missiles.

Matra believes that "only a projectile that is very low profile until it reaches its target, has an extremely stealthy (and thus subsonic) vector, and is equipped with a quiet homing head will enable" antiship or for that matter air-to-surface missiles "to escape future antimissile defenses and hit the objective!"

With this in mind, Matra is developing the air-to-surface Apache that will come out in 1996 and is studying a "very stealthy" subsonic antiship project. The latter could by ready by 2000 at the earliest or, if current economic conditions prevail, by around 2005.

Matra is developing the Apache in collaboration with Aerospatiale to equip the Rafales and Mirage 2000-Ds. The company is also co-producing it with Deutsche Aerospace as part of the "Modular Abstands-Waffe (MAW)" program to outfit the Luftwaffe's Tornados. But the Apache could also equip the F14s, F16s, F18s, or the EFA.

The missile is a 5.1-meter-long standoff cargo missile that weighs 1,230 kg. It carries 500 kg of payload consisting of 10 Kriss anti-runway submunitions being developed by the Velifer group (Matra + TBA).

According to Philippe Turpin, the Apache's strengths are its modularity, which allows configurations to be changed according to need, and its stealth and "smart" navigation, which are consistent with the missile's flight profile. The Apache is guided by an inertial unit that resets by matching landmarks and altimeter readings until it reaches its target. The missile also recognizes the target by comparing images generated by Thomson-CSF's Promethee homing head. The turbopropelled Apache is thus accurate to within 10 meters after a ground-following flight of 150 km.

Moreover, the French firm is proposing a derived version with a range of 250 km for Britain's CASOM air-to-surface standoff missile project. CASOM is part of the SRA 1236 program, whose bid invitation has been postponed to 1993 (see AIR & COSMOS/AVIATION MAGAZINE INTERNATIONAL, No 1393).

Matra also has a government contract to study two other longer-range variants which would take the form of stealth cruise missiles carrying a single warhead or submunitions. One would complement Apache and would be an airplane- or ship-fired missile with a range of 400 km. It could be ready by 1998-2000. The other would use different guidance modes than the Apache and would travel much farther than 400 km. According to Philippe Turpin, "Apache's design allows it to go as far as 1,000 km!"

[Box, pp 18-19]

Exclusive Report: ONERA-Matra's "Crude" Ram Will Be Certified in 1994

ONERA [National Office of Aerospace Studies and Research] and Matra have just finished building the first preliminary "crude" ramrocket missile which will be flight tested in 1994. Bernard Petit, ONERA's Missile Coordinator, says that the Office and manufacturer have performed wind-tunnel and altitude simulation tests on the "crude" ram and have validated its functioning (including self-regulation) up to Mach 3 and 20,000 meters. ONERA and Matra are partners in the avant-garde program.

The rocket is the product of 14 years of exploratory technology research and development, which the Missiles Directorate (DME) of the General Weapons Delegation (DGA) has sponsered and funded since 1978. To our knowledge, it has no equivalent anywhere in the West, including the United States. Moreover, collaboration has been set up between ONERA/Matra and the USAF, which will use the French crude ram technology on the American VFDR preliminary missile.

Among the crude ram's possible applications, Matra is now considering its use on new generations of antiradar missiles (ARF), as Noel Forgeard, Matra Defense's CEO, recently explained to us.

Aerospatiale is thinking about using it on its light antiship missile (ANL). The ANL is an approximately 200-kg missile that carries 30 kg of payload, flies at Mach 2, and travels 30 km. It is being proposed for the NH-90 navy helicopter.

Actually, ONERA is now working on the second generation of "crude" ram missiles. The rocket is so named because it is a simply-designed powder ram rocket that can be used to make a smaller, lighter, and thus cheaper missile than classic solid-propellant missiles, explains Paul Kuentzmann, ONERA's Energetics science director.

It is crude ram design that ONERA has been working on with Matra for 14 years (1978), initially in the first "Preliminary Crude Ram Model (MPSR-1)" program. Research began in order to make a low-altitude surface-to-air missile (SAMAT) that interested Matra. It then continued under a state exploratory development contract starting in 1981. Six experimental vectors were fabricated, equipped with the first generation of "crude" rams. Five of them were fired between December 1983 and the end of 1985. Three successfully demonstrated the required performance, namely to travel twice as fast and far as the short-range surface-to-air missiles of the time, explains Bernard Petit. That is, at Mach 2 at low altitude, with a propelled range of about 20 km. A missile was used to test the ram's operational limits and showed, in particular, that the missile was not greatly disturbed by air-intake pumping. Finally, the last launch demonstrated the ram missile's capacity to function at Mach 3 at 10,000 meters.

The MPSR-2 on which Matra and ONERA, assisted by Aerospatiale and the SNPE [National Company of Powders and Explosives], are working is even more elaborately simple. The missile is comparable to a two-stage, bistructural engine. A single order cues pyrotechnic igniters to fire up the two powder grains (booster and sustainer) at the same time. The only combustion chamber, placed in the rear, initially holds the accelerator's powder grain, which burns in less than three seconds to bring the missile to Mach 2. Once the combustion chamber is free and the frangible discs of the four air intakes are ejected through simple differential pressure, the gas generator takes over and reaches its operating speed in 2.5 seconds. It then slowly burns a semi-propellant in just over 40 seconds.

Two propellant formulas have been developed. SNPE's was chosen because it could be industrialized more easily than ONERA's, which performed a bit better.

The secret of the "crude" ram is its extremely stripped-down engine that makes it very reliable and cheap. It has no nozzle (the back shape of the accelerator replaces it), no sonic throat in the gas generator, and no flame-retention baffles in the combustion chamber. Unlike the American crude ram, there are not even any slide valves to regulate fuel flow. For the French ram is "self-modulating" (from one to three). Modulation is very cleverly taken care of by the intrinsic characteristics of the generator's semi-propellant, whose gases are burned with outside air while maintaining an optimal mixing ratio at different missile altitudes and speeds. Combustion is automatically regulated as a function of air flow and pressure differential (and thus outside pressure), explains Paul Kuentzmann.

"Self-modulation enables the rocket to go higher and faster," stresses Bernard Petit. "It is thus possible to reach Mach 4.5 and an alititude of over 20,000 meters." The missile's range simply depends on the quantity of powder—and the missile's flight profile. At low altitudes, for instance, the current preliminary vector travels 40 km. But flying at high altitude and fired from the ground, its range exceeds 140 km. Fired from a plane, the missile reportedly has a range of over 200 km. In air-to-air applications, the ram missile could maneuver under 40 G. Since the caliber of the crude ram can vary greatly—from a diameter of 40 mm to 200 mm (MPSR-2)—the technique can produce missiles of varying size, from 100 to 250 kg.

ONERA and Matra have already performed 40 bench tests of the MPSR-2's 200-mm crude ram at Palaiseau and Modane. The engine has thus been tested and qualified for the entire flight envelope and temperature operating range. The next and final big step will be the two launches of self-propelled missiles from the ground to demonstrate their suitability for surface-to-air and air-to-surface missions. ONERA and Matra will execute the launches back-to-back in 1994.

The program will then continue with various "related tasks," including a study of the crude ram's aging and vulnerability that will be conducted by ONERA, Matra, and Celerg (Aerospatiale and SNPE). Aerospatiale will also build a composite (wound with carbon fibers) missile structure, that will reportedly make for a weight and performance gain of about 20 percent. Furthermore, an agreement on "crude" rams has been concluded between France and the United States. The accord brings together the ONERA/SNPE team with the ARC/CSD/Hercules team designated by the USAF. It will enable ONERA to test different American gas generators (manufactured according to French specifications) in exchange for a combustion chamber, which is the sensitive part of the French ram. Since the air force has launched a program to test a crude ram (but with regulation valves) that is 178 mm in caliber and adaptable to the AMRAAM, the combustion chamber will be bench tested on a preliminary American powder ram model, the "Variable Flow Ducted Rocket" (VFDR). The American air-to-air missile has to be equipped with a new booster to increase its range while shrinking to fit in the hold of the new F-22 stealth fighter (see AIR & COSMOS/AVIATION MAGAZINE INTERNATIONAL, No. 1401).

[Box, p 22]

France Leads in "Reduced Risk Munitions" (RRM)

France leads the world in "reduced risk" or "RRMed munitions." RRMs are munitions (missiles, bombs, shells, etc.) that have been made intrinsically stable by the nature and functional layout of the "energetic materials" that make up the powder boosters and explosive charges. The latter (unlike current materials) then lose any tendency to detonate when subject to thermal or mechanical attacks such as fire, bullet impacts, or indirect detonation. A munition toughened in this way is eligible to receive the highest "RRMed" label, "level 3." The classification scale was established in France by the SNPE.

Indeed, it is the French weapons chemical manufacturer and big national powder company that is responsible for the technological advances in RRMed munitions, which are now recognized the world over, even in the U.S. The SNPE has been working for 20 years to develop low-sensitivity explosives, notably polymerized-binder composite explosives.

Moreover, the US Navy has just awarded a new contract to the SNPE (through its subsidiary AEMC) for the optimization of "RRM" criteria (blast resistance, etc.) on airborne bombs and underwater munitions; the contract provides for a real demonstration in early 1993. SNPE explosives-department director Alain Freche points out that the demonstration is a followup to the first one conducted for the US Navy in mid-1991 in which a 250-kg pile of bombs was shown "not to detonate under indirect influence."

Indeed, navy personnel are the first ones to take an interest in shock-proof munitions, which substantially boost the "survivability" of platforms, particularly the biggest ones (aircraft carriers) in case of fire or on-board explosion. In France, the DGA has decided to reduce the risk of all the munitions aboard the future Charles de Gaulle nuclear aircraft carrier that will go into service in 1998. The measure will affect everything from the Rafale's 30-mm munitions to their missiles, which include MICAs, Magic 2s, Exocet AM39s, and AS30Ls.

But the RRM process is destined to become more widespread. This is because, as Emile Blanc, SNPE's CEO, stresses, the new quality will sooner or later become a "selling point." That likelihood is what prompted the creation of the "RRM Club" in late October, whose members include the SNPE, Aerospatiale, GIAT Industries, Matra Defense, and Thomson Brandt Armaments.

ENERGY, ENVIRONMENT

CEA Testing Heavy-Metal Waste Treatment Methods

93WS0164C Paris L'USINE NOUVELLE in French 3 Dec 92 p 41

[Article by Herve Kempf: "'Metallophagous' Mushrooms: Method Proven Operational in Laboratory, Now Near Pilot Stage]

[Text] Techniques borrowed from pharmaceutical and mining industries provide new solutions to the problem of heavy-metals pollution.

One of the thorniest industrial pollution problems—the heavy metals, such as cadmium, lead, and zinc, present in many effluents—may yet be solved by mushrooms that are rejected by the fermentation industries. Although it is known that heavy metals can be isolated by means of ion-exchange resins, the technique's costliness is a drawback.

A new method, using mushrooms, is expected to halve this cost. Next month, under the Mycelium research program, a pilot operation is to be launched, using the adsorbent power of *Penicillium*, tested in the CEA [Atomic Energy Commission] Transfer into Vegetal Systems Laboratory at Grenoble. The filamentous mushroom is a residue of the manufacture of penicillin. It is transformed into granules approximately 100 microns in diameter, and placed in the column of a fluidized-bed that is traversed by the polluted effluents. Within a few minutes at most, the metallic ions attach themselves to the filaments. The pollution is thus transferred and concentrated. The 5 grams of cadmium contained in a cubic meter of water, for example, are found in 1 kilogram of the mushroom powder. This powder can be incinerated, or washed in a desorbing acid solution. The bath obtained can then be treated by precipitation or electrolysis. The mushrooms are reusable at least five times. Participating in the project together with the CEA are Union Miniere de Belgique and Gist Brocades. It is being coordinated by Bertin.

Two Bacteria Tested

The technique could also be applied to sites contaminated by heavy metals, according to a study carried out by the ATE [Antipollution Technique Enterprise] company. The trick here is to first solubilize the metals present in the soil. A bacterium discovered in the mines of South Africa could provide the solution. It is used in the gold mines to recover the last traces of the precious metal from the mine waste.

Two types of bacteria are being tested. Those of one type act by bioaccumulation, that is, by directly ingesting the metal. Those of the other type secrete an enzyme that acts as a biochemical catalyzer and solubilizes the metallic salt. The solution is then pumped, and can be treated in a mushroom filter.

For the time being, the method is only operational in a laboratory. It could revolutionize the treatment of soils contaminated by heavy metals. The principal technique used currently consists of isolating the terrain concerned, by means of hermetically sealed walls. It does not do away with the pollution.

Mercedes Develops Process To Recycle Auto Body Metal

93WS0174A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 8 Dec 92 p 8

[Article: "Auto Scrap Metal Turned Into Steel Again; New Metallurgical Reprocessing Technique Now Proves To Be Successful"]

[Text] Stuttgart (DPA/VWD)—A new smelting process promises the nearly complete recycling of used automobiles. Commissioned by and developed for the Stuttgart automobile manfacturer, Mercedes-Benz, Inc., this metallurgical reprocessing technique by means of which steel

is reclaimed by melting down scrap auto bodies has, after a two-year planning and testing period, proven itself to be "environmentally correct, technically feasible, and economically justifiable," member of the board Klaus-Dieter Voehringer said.

It is now anticipated that the process will be implemented in a steelworks. All types of vehicle bodies could be almost completely melted down and reused in the manufacture of cars. Refrigerators could also be disposed of in this way. But Mercedes does not want to invest in the cost of the expensive recycling machinery, which will come to from about DM120 to DM150 million. By its own account, the automobile company has contributed about DM15 million for research. They are currently looking for a steel producer where a recycling plant could be installed. In Germany three locations are being discussed, among which are the Max Iron and Steelworks in Unterwellenborn (Thuringia), the Max Iron and Steelworks in Sulzbach-Rosenberg (Upper Palatinate) and a small steelworks that cannot be cited by name. It will take about two and a half years to build the plant. In the long run there would have to be several plants in Germany to avoid a long hauling distance.

To solve the problem, as early as 1990 the company had, together with the Austrian steel producer, Voest-Alpine Steel, Inc., founded the Company for Studies on the Disposal of Used Vehicles (EVA), which developed the method in question.

According to EVA, all recyclable equipment, components, and fuel are removed from the used car. The rest—about 25 percent of the car, which up to now has been chopped up and hauled to the waste dump—is then fed into a melting furnace to produce steel. A melting unit can dispose of about 300,000 vehicles a year. About 500,000 tons of melted metal would be obtained in the process.

MICROELECTRONICS

JESSI Status Report Presented at Munich Electronics Fair

93MI0209 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 14 Nov 92 pp 10-12

[Text] The JESSI [Joint European Submicron Silicon Initiative] organization gave an overview of its work in progress and results achieved to date during the Elektronica fair in Munich. JESSI is a EUREKA [European Research Coordination Agency] program and aims to improve the competitiveness of the European microelectronics industry. It was launched in 1989 and reorganized last year. Expenditure for 1992 totaled ECU350 million.

Raimondo Paletta, chairman of the JESSI program, called for it to be extended beyond 1996. "The future of the European microelectronics industry is closely bound up with future product innovations, and these now depend on silicon chips," was the reasoning behind Paletta's demand. The general consensus is that microelectronics will only be able to prove its real potential towards the end of the decade.

In his survey, R.P. Kramer from Philips emphasized that fruitful collaboration had been established among European semiconductor manufacturers: 0.7-micrometer technology was already available, and 0.5-micrometer technology was on the way. All the participants were profiting from the exchange of production technology know-how. The 8-inch silicon wafer production project was the result of close cooperation with the JESSI Equipment and Materials subprogram. All the work currently under way in the Modern Mass Production Technologies project followed on from previous memory project topics: two of the latest results were the 16-Mb EPROM [erasable programmable read-only memory] and the shrink version of the 4-Mb DRAM [dynamic random access memory], designed to 0.65-micrometer rules.

A digital 0.7-micrometer CMOS [complimentary metal-oxide semiconductor] production process had passed the acceptance test, while the design rules and process architecture for the 0.5-micrometer generation had been defined. Analog options with a smaller operating voltage are being developed. This means that digital and multifunction CMOS chips will be ready in good time for JESSI's Europrojects (HDTV [high definition television], DAB [digital audio broadcasting], automobile safety electronics, mobile radio telephony, broadband communications).

New Financing Models Called For

The following were among the milestones reached in the Equipment and Materials subprogram last year:

- The i-line stepper project (365-nm wavelength) was successfully concluded. Production runs of lithography equipment of this type were delivered, and production of the requisite photoresist was stepped up;
- The first 200-micrometer diameter (8 inch) silicon wafer with oxide-nitrite layers were delivered to users;
- An improved silicon crystal pulling technique was developed: sample production was showing good results;
- Milestones were reached ahead of time in the Automated Clean Environment Project. Cooperation with the American SEMATECH project in this field is very promising.

E.J.R. Kamerbeek, from ASM International, the Dutch equipment manufacturer, pointed out that Europe-based semiconductor production equipment and materials firms are facing difficulties. This industry's future depended on a healthy chip industry that needed to keep its production equipment up to date so that it could make the next generation of chips. But the cost of developing this equipment was now so high that it could

no longer be borne by the industry, which tended to consist of medium-sized firms. As the small number of buyers in Europe limited the number of machines made in each series, financing prototypes of such machines had long been a problem. Kamerbeek called for special solutions to be sought so that prototypes could still be funded: After all, they represented a substantial portion of equipment development.

Application Subprogram

A. Sauer (Siemens Nixdorf Information Systems) presented parts of the Applications subprogram. The highly complex chips of the future needed particularly high-performance design tools if they were both to satisfy time-to-market demands and to maintain a reasonable cost- price ratio. The development of modern CAD [computer-aided design] tools was thus the second major part of this subprogram, alongside the product-oriented "flagship" projects.

The JESSI Common Frame Project formed a common framework for creating an infrastructure for all computer-aided working environments in an open network, regardless of customized applications. The second version of the complex software that it required had become available just a few weeks previously (and was already being marketed under the brand name SIFRAME). This was the first demonstration that the development, maintenance, and configuration of such integrated CAD systems was actually possible. All CAD tools developed under JESSI were integrated into this framework.

The other prototypes in this subprogram included a tool that could be used to solve problems of electromagnetic compatibility. These software tools too had already been tested on complex chips. Sauer pointed out that a first international multiproject wafer with eight different chips had been produced under the SMI project (which facilitated access to microelectronics for small and medium-sized enterprises).

Basic Research

There are two projects under this heading: ADEQUAT, which was working on "Quarter-Micron CMOS Technology" (a more detailed report was given by Prof. De Keersmaecker), and a project on efficient packaging technology (assembly and wiring techniques for future chip generations). The original JESSI basic research program could not be implemented, as the financial resources were not available. According to Professor R. Lawes, from the Rutherford Appleton Laboratory, Chilton, UK, this situation was unlikely to change in the near future. The ADEQUAT project was currently being funded by the EC and the packing project by the national governments. In Lawes' opinion, one positive aspect was the efficient collaboration between industry and the academic world: Europe still had some of the world's best research laboratories.

Wafer Production: Automated and Highly Flexible

Rapid changes in technology and the rapid growth in the number of products that are manufactured in the same production plant require flexible and largely automated wafer production. Flexibility is needed to govern the various products and the different processes that they require in an ASIC factory. Automation is necessary to avoid process-step and operating errors and to keep costs down. Most of the firms that invest in this kind of infrastructure operate in sectors such as clean room facilities, wafer handling, gas and chemical supplies, and all CAM/CIM [computer aided/integrated manufacturing] systems.

Heinz-Wilhelm Ehlbeck, from Telefunken Electronic GmbH, reported that two JESSI projects—flexible automated wafer production, and automated control systems for wafer handling—covered a substantial part of this infrastructure requirement. The firms working on them are from Germany, France, and Great Britain. Both projects have been running for more than a year and have their contacts, both inside JESSI and outside (in SEMATECH, for instance, with which they were preparing a joint project). Moreover, the blueprint a flexible, automated wafer factory of this kind was already ready.

JESSI Silicon for Future Digital Audio Broadcasting

After the medium-wave radio of the twenties and the UHF radio of the late forties, there was now a new arrival on the scene: digital audio broadcasting. The relevant EUREKA project, No. 147, would shortly be converted into a standard, but JESSI was running in advance of it: Work was already under way on implementing the draft EU-147 design on silicon. The results would pave the way for subsequent commercial DAB receivers.

The JESSI team expected the first DAB receivers to appear on the market at the Berlin Broadcasting Fair in 1995. Project leader W.G.J. Kreuwels, from the Philips research laboratories, believed that the DAB receiver will still need about a dozen different chips when it came onto the market in 1995. This meant that it would still not be possible to implement DAB as a dashboard radio. DAB receivers would be into the second generation before they would comprise so few chips that it would be feasible to incorporate them into car radios.

Quarter-Micron Technology

Prof. R. De Keersmaecker, from the Interuniversity Microelectronics Center (IMEC) at Delft University, reported that more than 100 scientists were working on 0.25-micrometer CMOS technology for JESSI. These ultrafine structures are a prerequisite for integrating entire systems on one chip in the future. The JESSI ADEQUAT (Advanced Development for Quarter-Micron CMOS Technology) project was launched on 1 August 1992. It followed on a preliminary project that had begun back in the JESSI start-up phase. The budget

for the first 18 months of the main phase of this project, until January 1994, totaled ECU27.5 million. ESPRIT III was funding 50 percent of this budget.

Eight participants alone accounted for 80 percent of all those engaged on the project; they fall into two groups: four were from such leading research facilities as DIMES (Netherlands), the Fraunhofer Society with its AIS [Integrated Circuits Team] and IMT [Institute of Microstructure Engineering] (Germany), GRESSI [Grenoble Submicron Silicon Initiative] (France) and IMEC (Belgium). Four other partners were among the major European semiconductor manufacturers, such as GEC-Plessey, Philips, SGS-Thomson, and Siemens. The remaining 20 percent of the employees were distributed over 14 associated teams in various universities and firms.

The project aims to develop the fundamental process steps and modules required for logic chips in 0.25-micrometer CMOS technology. The first components in 0.35-micrometer CMOS technology should be made by January 1994, and the way is being paved at the same time for the advance into 0.25-micrometer technology.

EC: JESSI Program Subsidizes Semiconductor Equipment Upgrades

93BR0231 Paris ELECTRONIQUE INTERNATIONAL HEBDO in French 26 Nov 92 p 7

[Article signed D.G.: "JESSI Wants to Evaluate Manufacturing Equipment for Semiconductors"]

[Text] JESSI [Joint European Submicron Silicon Initiative] has prepared a European program for evaluating semiconductor manufacturing equipment which will cost between $10 million and $15 million per year.

In keeping with their desire to promote the manufacture of semiconductor production equipment, the JESSI leaders have set up a program to evaluate this equipment. This has been submitted for financing approval to the EC authorities and the governments concerned. If approved, these authorities will contribute $10-15 million of the annual budget to companies which undertake systems evaluations. An annual average of five to seven evaluations is planned. The project initiators hope that it will be approved within the first quarter of 1993.

The program includes the responsibility for the evaluation; and payment for the production facilities will only be made by the companies concerned when they have decided to purchase the equipment. In practice, IBM could be part of this project, along with Philips Electronics NV, Siemens, and SGS-Thomson. Currently, this evaluation program is being discussed with representatives of the national governments and with Brussels. The results should be made public in less than a month.

If accepted, it will give a new breath of life to the European semiconductor manufacturing equipment industry, which supplies only 20 percent of European semiconductor manufacturers. In reality, European semiconductor manufacturers are no longer willing to take risks and they play it safe by buying only from the large world suppliers, i.e., from the Americans and the Japanese. On average, an evaluation lasts six months and costs $2 million.

NUCLEAR R&D

Belgium Decommissions PWR Nuclear Reactor

93BR0214 Zellik BELGIAN BUSINESS & INDUSTRIE in French Dec 92 pp 47-48

[Article by Marc Magain: "Mol in Kit Form"]

[Excerpts] In Mol, the CEN [Nuclear Energy Research Center], Framatome, Siemens, and Belgatom are participating in a pilot program for dismantling the BR3 nuclear reactor. A real test-bed for the future.

BR3, the second civilian industry pressurized water reactor (PWR) in the world and the first in Europe, is a monument of European nuclear history. This prototype, with an output of 41 MW, was put into operation at the end of 1962 on the CEN site in Mol near Antwerp. Belgium had obtained this Westinghouse technology transfer from the Americans, as compensation for a "feat of arms": the supply, through Belgium's colony of Congo, of uranium vital to the "Manhattan" military project that gave birth to the Nagasaki and Hiroshima bombs.

Eternal Prototype

For a long time, the Mol reactor was a training center to which engineers flocked from all over the world. BR3 went on to focus on irradiation tests of advanced fuels. Despite a guaranteed workload for many years to come, the reactor was definitively shut down in June 1987, on the initiative of the Belgian authorities.

Was a page in European nuclear history finally turned? Not really, BR3, thanks to an EC program, remains a prototype. The EC has kept the Mol reactor in a pilot program for the dismantling of nuclear installations, along with the graphite-gas plant at Windscale (Great Britain), the steam plant at Gundremmingen (Germany), and the reprocessing plant in the Hague [Netherlands].

The Mol experiment, however, captures the most attention. It is the only project to involve a PWR power station, most widespread in France (52 units) and in Europe, but also throughout the world (representing 50 percent of existing installations). BR3 has become a laboratory with engineers studying dismantling methods and technologies. Together with the CEN, companies such as Siemens, Framatome, and Belgatom have well understood the project's importance. On a 50-50 basis with the EC, they are providing the 200 million Belgian francs [BFr] required for the first dismantling phase.

Lucrative Market?

The nuclear manufacturers calculated that this modest investment was justified by a market that could become quite lucrative in the long-term (see box).

However, the dismantling of BR3 is not a first. Francois Motte, project manager, stipulates: "The Americans have already dismantled the Shippingport Plant, the BR3 twin and first PWR plant in the world. Their main preoccupation, however, was to liberate the site more than to develop technologies that might be applied to commercial plants." [Passage omitted]

In Mol, the first phase was completed a few months ago. After dismantling the reactor's internal parts, the thermal shield—a tubular element (2.5 m high, 1.4 m in diameter, and 72 mm in thickness, weighing 5 metric ton) of stainless steel which protected the reactor vessel from gamma rays emanating from the reactor core—was cut up into 40 separate pieces of 50 by 50 centimeters apiece. Three different technologies studied by former European programs were tested: the plasma torch, electro-erosion, and mechanical sawing techniques.

Francois Motte: "It is much too early to make a complete evaluation of the different technologies employed. These tests should allow us to evaluate the two major choice factors: financial cost and radiological hazard for the personnel; in other words, the exposure level to which they are submitted."

Significant

The example of cutting the thermal shield—underwater and by remote control because as this element emits a lethal level of radioactivity—is especially significant. The plasma torch cuts 1 meter of stainless steel of the aforementioned thickness in 3.3 minutes. But the operation produces a residue that necessitates a long and difficult water filtration process. In addition, it causes emission of radioactive aerosol gasses. Francois Motte: "We were, therefore, obliged to work blindly in an enclosed area. At the end of the day, the traditional mechanical sawing method proved easier to handle," although this cold method takes 40 times as long (133 minutes) to cut up 1 meter of element in aluminum. However, the resulting waste consists of chips that are directly recuperated at source by suction.

These initial tests are of great interest to the nuclear world. For the time being, electricity producers are planning for the "coming hour of dismantling," after the year 2000. In general, the dismantling cost is estimated at 15 percent of the initial power station investment. Based on which methods? On which technology?

Excellent questions! Researchers at Mol are hoping to give us some rough answers.

[Box, p 48]

Big Gamble

Almost 450 nuclear reactors are in operation around the world today. Fifty or so, essentially prototypes and head of series, of low output (200 MW on average), have been definitively shut.

At the time of their development, nuclear engineers had counted on a life span of 30 or so years. Since the setup of programs such as PLEX [Plant Life Extension], it is widely accepted and hoped that the life span of most plants under normal operating conditions will be extended to 40 years. If this life span of 40 years is maintained, the number of plant closures before the year 2005 will be small.

The average age of operating nuclear plants is a little over 12 years, but after the year 2010 the increase in the number of plants to be decommissioned will be exponential. The peak will be attained in 2015, and will last for a decade or so. We have until then to develop the necessary techniques.

The Mol pilot project is designed to evaluate the financial and technological factors of these techniques. Its full three phases should represent a total cost of about BFr1 billion. This figure is difficult to extrapolate for commercial plants. Effects of scale are not easily calculated. Dismantling strategies have not been completely defined. Exact costs of storing waste has not been accurately calculated.

It also remains to be seen if decommissioning will be synonymous with dismantling. Some believe that postponed dismantling is the best solution, while others believe the process should move faster. As for UK engineers, they are watching the research taking place at Mol with a certain irony: after dismantling the nonradioactive and noncontaminated parts, they recommend to isolate reactors and bury them under a good layer of...English lawn!

SUPERCONDUCTIVITY

FRG: Thin Layer Depositing of Superconducting Material

93WS0174B Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 3 Dec 92 p 8

[Article by OEL: "Simplified Production of Thin Layers; Hoechst Expects Advances in High-Temperature Superconductors"]

[Text] Frankfurt—Following recent developments by the Frankfurt firm, Hoechst, Inc., the production of thin layers of high-temperature superconductors will be made considerably cheaper and simpler. Through these developments, their employment in electronic circuits could be perceptably sped up. The thickness of the layers is

variable and lies within micrometer range. Initial reports on measurements show that the critical temperatures of the layers, composed of yttrium, barium, and copper oxides, are in the neighborhood of 90° Kelvin and that critical currents of millions of amperes can be attained.

The new process involves a form of chemical precipitation from the vapor phase, CVD (chemical vapor deposition). Supercool solutions of the metal oxides, which are vaporized in a flash, are used. Hence these variants are called FMO-CVD (flash metal oxide CVD). The advantage of this is that the source material can be mixed from the different metal oxides of the high-temperature superconductors in exact proportions and continuously fed to the precipitation process.

The process can operate at temperatures of from 250 to 300°C and unwanted structural changes due to overly high startup heat can thus be avoided, which is especially advantageous with the extremely sensitive and complicated structures of the new high-temperature ceramic superconductors.

As numerous experiments have demonstrated, no protective gases or—for high-temperature ceramic superconductor materials—separate oxygen atmosphere has to be used now to produce superconducting structures. Still used up to now, separate vaporization units can be eliminated by turning stoichiometrically accurate source material into a single "solid" solution. The whole evaporation system can be built more simply.

The precipitation process even gets by with a quite simple temperature adjustment as the only decisive parameter and is, according to the developer, not very "sensitive." With this successful new process, Hoechst, Inc., finds itself facing the need for making a decision: "Shall it in future provide these kinds of high-temperature superconductor layers as products or shall it continue to produce only the extremely pure raw materials for the different classes of high-temperature superconductors?" The decision will be a difficult one since the process also allows for the production of flexible fibers or filaments, which are necessary for the transmission of strong currents without resistance. It would replace the techniques employed up to now—the inclusion of high-temperature superconductors in silver tubes—because of the much lower production costs.

And for another thing, there are many possible uses in the fields of electronics or electromagnetics, in which not wires, but thin layers are used. For additional information: Hoechst, Inc., Central Research Department, D-6230 Frankfurt/Main, 80.

TELECOMMUNICATIONS

Swiss ISDN Network Described

93MI0145 Milan L'INDIPENDENTE in Italian 15-16 Nov 92 p 11

[Article by Silvano De Pietro: "'Hello? I can see you.' Switzerland Follows the Innovation Track"]

[Text] Zurich—Little by little, almost slyly, the Swiss postal system is taking a decisive step and leaving its advanced technology behind to enter into the future of telecommunications. Not the spectacular and slightly frivolous realm of high television but practical applications with an immediate commercial value. A digital telephone network offering users new and multifaceted services has started operating in Switzerland as of 1 October.

The system, called "Swissnet" is practically the Swiss variation of the ISDN [integrated services digital network]. For years now, this system has been identified as being the telecommunications system of the future. Since networks were divided into telephone and data transmission networks users previously had to use a special line with a number and terminal for every individual device or service (telephone, telefax, telex, telepac, teletex, and videotex). Such a telecommunications network was clearly expensive and did not eliminate the risk of disturbances and a consequently reduced transmission quality. By replacing the analog system with a digital network which was also made possible by the wide use of optical fiber cables, multifaceted services and new functions can be obtained using just one line, one terminal, and without any noise or interference.

Beginning in 1989, the Swiss postal service introduced and expanded a digital commercial network for data transmission via computer. Now, with this recent step, the "Swissnet" network can be accessed and telephones, telefaxes, and videotex can be used simultaneously with the use of a videotelephone number, a businessman can, for example, call his customers and send them faxes at the same time without any disturbances on the line even if the other party is not hooked up to the digital network: All it takes is a special adaptor. In addition, from an office—where the installation of a switchboard is justified—videoconferences (whatever the distance of course) can be conducted while simultaneously calling a research institute, making connections to its database via computer, receiving statistics, and sending them via fax to all the other participants. This is what is done in a real meeting room, with all the participants physically present and with more than just one telephone line available.

All of this, however, is just part of the advantages that the ISDN telephone network can offer private users. Connections are faster and take just a few seconds, and two users of the new digital network can exchange large quantities of information simultaneously. For example, the number of the caller appears immediately on the display of the telephone called, so that the person receiving the call can decide whether or not to answer (or, vice versa, the person calling can make himself known and obtain an answer). In other words, anonymous telephone calls will no longer be possible. The immediate advantage for private users is the opportunity to use the videotelephone. This digital and technically sophisticated phone is already available. The problem to date was making it work with both voice and video

signals travelling on normal telephone lines. Now all this is possible and is opening up new commercial and marketing opportunities (for example, door-to-door product demonstrations). Meanwhile, pending an agreement on ISDN regulations by European producers and other partners, the Swiss postal system's program is moving ahead: Under the program all telecommunications services including radio and television broadcasting will be incorporated into a single integrated digital network by 1995. The confusion of antennas and radio transmissions will end and the user will only make one payment to "hook up to" the rest of the world.

European Telecommunications Standard, Trends, Markets Viewed

93WS0174C Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 8 Dec 92 p 8

[Article by Karl Tetzner: "Isolation of National Markets and Lack of Standards Hinders Telecommunications Market"—first paragraph is FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT introduction]

[Text] Munich—But the industry is optimistic on the threshold of the European internal market. Rapid growth of the telecommunications traffic across borders is anticipated.

A united Europe will have substantially more revenue from telecommunications to manage than it does at present. This is the unanimous conclusion arrived at by the experts at a lecture conference organized by the "Munich Circle," a science and industry organization for telecommunications research and application, that was recently held in Munich. Accordingly, manufacturers and suppliers will be geographically spread out over larger areas; the same applies to customers. The service industries in particular will grow. This new role for telecommunications is expressly recognized in the much-maligned Maastricht agreement (Article 129 b 1), Reinhard Buescher, a member of EC Vice President Bangemann's cabinet, stated. This could trigger investments of from DM180 to DM200 billion in the near future. Bueschner estimates that there will be an annual increase of 5-6 percent in domestic telecommunications traffic and as much as 14 percent transnationally.

Gerd Tenzer, a member of the board of directors of the German Federal Post Office Telecommunications Division, suggested that realization of the European economic and social community will largely depend on whether we also at the same time succeed in developing a European telecommunications community. Tenzer raised several sins of the past, the shortcomings in the area of standardization, for example. Until 1990 Europe allowed itself the luxury of six mutually incompatible mobile communications systems, which not only blocked transnational traffic, but also prevented cost-lowering, mass-produced terminals. Likewise, in Europe there are eight different telephone exchange systems as against two in Japan and three in the United States. In future Europe can only flourish with a balanced relationship between coordination (that is, uniform standards) and liberalization. This holds true for the equipment as well as for the services that evolve along with it. In connection with this, there are still imbalances in the wide-band ISDN [Integrated Services Digital Network], which is in future supposd to be Europe's infrastructure, but, because of an early individual start in some of the countries, they cannot always be smoothly hooked up with one another. The immediate goal must be a Euro-ISDN. GEN, a meshed fiberglass network deployed between Europe's junction points for services up to to 2 megahertz, should be added to it. Even higher goals are to be set with METRAS, a wirable, 155-megabit/second transport network to be completed by 1995, that might compete with the satellite-supported transmission of television programs in the shuttle service. But, according to Tenzer, these and additional overall European plans must be accompanied by stepped-up common research anddevelopment. For this purpose, the Telecommunications Office will spend about 1.7 percent of its turnover in 1993, or just short of DM1 billion, not counting the reimbursement of the industry for its research and development, which is included in the prices of the equipment it provides.

Gerd Lorenz of the University of Munich gave a talk on innovation and competition in the telecommunications industry and in it pointed out the risks: "The existing market provides us with no information on the development of future technological innovations because the signals emitted by competition relate to what happens in the market from day to day and don't tell us anything about whether, how, and when the results of basic innovations will be relevant. Not a single relevant market signal was received during the development phase of transistors or microelectronics. Only visionary minds knew—even if only intuitively—what could happen to the market because of them."

Can Europe be a telecommunications partner with equal rights in the world? Gerhard Zeidler, the chairman of the board of Alcatel SEL, pointed out that people often overlook the fact that only 20 percent of the world communications market (about $410 million in 1991) consists of equipment while 80 percent is income from the provision of services. The EC of today accounts for 28 percent of equipment sales, the United States 31 percent, and Japan 13 percent. While the [EC's] share of telephone exchange technology dropped by 10 percent to 40 percent within five years, the importance of terminals grew.

In a few key technologies like microelectronics and optoelectronics, as well as software, Europe is still seeking connections with Japan and the United States, but it is fully keeping pace with telecommunications technology, although there is [other] leadership in some technologies, for instance, in basic software by the Americans and in flat display by the Japanese. Europe could,

in the near future, be placed at a disadvantage because of its slower-running innovation processes. Moreover, the big corporations in Japan and the United States offer better vertical integration. With respect to this, Community projects like RACE [Research and Development Program in Advanced Communications for Europe] and EUREKA [European Research Coordination Agency] and uniform standardization must intervene. The founding of ETSI (European Telecommunications Standards Institute) has given a signal. The impulses it emits could promote the exports of the "United States of Europe." The importing of the European mobile radio system, GSM [global system for mobile communications] by Australia is an example of this. What is called for is a strengthened partnership, as is customary in the world of microelectronics today. This sort of arrangement would also support European efforts to shape the eastern European market deep into Eurasia, which has been largely untapped by modern technology.

While Zeidler was relatively optimistic about Europe and the eastern European areas, he took a skeptical view of the "South," that is, mainly Africa. Relations there have dramatically worsened over the past few years. The population explosion and along with it the growing difficulties in supplying Africa with food and energy have increasingly reduced the developed countries' ability to create infrastructures on their own. "Europeans can today no longer talk of cost-neutral activities, rather what is clearly involved are business transactions that operate at a loss which call for completely new kinds of partnerships. In some cases this could lead to a situaiton in which, in order to ensure being supplied with its basic telecommunications, a country completely adopts not only the supplier country's technology, but also completely hands it over to the operation of the network."

Hans Baur of the board of directors of Siemens, Inc., asked whether a new industry policy is necessary in view of all of this. First, he disputed the criticism of European manufacturers and telecommunications equipment that is sometimes heard. Alcatel and Siemens occupy second and third place after the market leader, AT&T, among the 13 biggest producers worldwide. As the third biggest European firm, Ericsson occupies sixth place and Bosch 12th (calculated in 1990).

Baur gave Germany's standing the now-familiar poor grade. He said that Germany has the highest labor costs and taxes, the shortest time spent on the job and the shortest running time for machines per year, the lowest return on firms' investment and for that the largest number of hours lost through absenteeism, the oldest students, and the youngest pensioners. He cited a graphic example from his own company: In India software engineers at the local Siemens-Nixdorf plant work 47 hours a week at the same level of productivity as in Germany, but at one-tenth of the cost. In addition to all this, there are the grants for research and development, which vary greatly [from one country to another]. In Germany they amount to 10 percent at their lowest, while in the United States, Canada, and Japan they come to 50 percent, and in France to as much as 60 percent. This belongs to the nasty chapter of distortion of competition, just as do the still by far not eliminated obstacles to free access to markets—this still holds true for Europe as well. Jozef Cornu of the board of directors of Alcatel NV, Paris, voiced a similar opinion. He complained about market interventions all over the world and asked whether, instead of bemoaning "fortress Europe" after the creation of the uniform internal market, we should rather ask ourselves whether the markets of Japan and America are open. By way of example, there are still no public calls for bids for telephone exchange technology in the case of AT&T Long Distance, Bell Canada, and Televerket [Telecommunications Office] in Sweden. The Japanese telecommunications administration, NTT, has gone even one step farther and ordered a new operating system.

Cornu addressed the economy and ecological issues. Videophones and video conferences can save working hours, reduce fuel consumption, and permit further decentralization of services. Frenzied development is anticipated in the industry in connection with this. At a press conference held in connection with the Munich Circle conference, Helmut Ricke, the head of the German Federal Post Office Telecommunications Division, had this to say: "I expect a videophone to cost DM5,000 and, in the long term, DM2,000." Today the Telecommunications Office is still selling these instruments for DM38,500 (plus value added tax).

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